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ORIGINAL PAPER

Water quality of Kaptai reservoir in Chittagong Hill Tracts of Bangladesh

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Abstract: A study was conducted in Kaptai reservoir, one of the largest man-made freshwater lakes of South-east Asia, to determine present status of water quality and its suitability for fishing and other uses. Water samplings were from middle part of the reservoir at 0.2 and 0.8 fractional depths at five different locations from upstream to downstream viz. Burburichara, Maichchari, Subolong, Basanthakum, and Rangamati. Water analyses show that concentrations of NO_3-N, K^+ and total P, and suspended solid at all the sampling stations were beyond the recommended values for fish culture. Concentrations of Na^+, Ca^{2+}, Mg^{2+}, SO_4^{2-}, Cl^-, total dissolved solid (TDS), dissolved oxygen (DO) and chemical oxygen demand (COD) were within the standards for aquaculture. Concentrations of NO_3-N, SO_4^{2-}, K^+ and total P showed no definite trend with depths, locations as well as rainy and dry seasons. Water pH, conductivity, Na^+ and HCO_3^- contents were lower in rainy season, and DO and COD higher at almost all the locations in both the depths, compared with dry season. Total solids and concentrations of TDS, DO, COD, Ca^{2+}, Mg^{2+} and Na^+ were higher in upstream and decreased gradually towards downstream in the reservoir. Concentrations of DO and Ca^{2+} and pH were higher and Mg^{2+} less at 0.2-fractional depth than those at 0.8-fractional depth at almost all the locations. The reservoir is in mesotrophic condition containing high concentration of NO_3-N and total P, in alarming status with the presence of excessive suspended solids from urban pollution around the town. It is necessary to adopt measures for protecting water quality in the reservoir due to such deteriorations.

Keywords: Karnaphuli river; lake water quality; Chittagong Hill Tract; inland aquaculture

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Introduction

Kaptai reservoir was created with the construction of an earth dam across the Karnaphuli River at Kaptai, about 70-km upstream from the estuary of Chittagong, in 1955 for production of hydroelectricity, which came into operation in January 1962 (BPDB 1985). Karnaphuli River lies in the southeastern part of Bangladesh. This river was originated from Lusai hills of India, travelled more than 160 km and met to the Bay of Bengal near the Chittagong port. Three main streams namely, Karnaphuli, Kasalong and Chengi and their innumerable small streams joining near Rangamati formed flow of Karnaphuli River. Kaptai reservoir is one of the largest man-made freshwater lakes in South-east Asia (Fernando 1980). The streams combining together covers 11 008 km^2 with water surface area of 588 km^2 with maximum width of 4 km varying storage capacity from 1456 million m^3 at dead storage at 23.165 m above MSL to 6 477 million m^3 at full reservoir at 33.22 m above MSL. Bed materials of the lake were variable ranging from clay to medium sand (BPDB 1985). Most parts of this watershed are mountainous with some ranges exceeding 2 438 m elevation above MSL. This mountain region with beautiful landscape is comprised of semi-consolidated and consolidated rocks, possessing steep slope of elevation ranging from 350 to 1 000 m above MSL and homes of at least 12 indigenous communities. With the construction of Kaptai dam, the created lake submerged about 22 000 ha of cultivable land, swallowed homes of 18 000 families and rendered about 100 000 people homeless. In addition, Kaptai project also created other adverse impacts like change in occupational structure of people, loss of forest resources submerging 75 km^2 reserve and 600 km^2 un-classed state forest areas, and decline in wildlife and creation of drinking water (Newman 1974). With the loss of landmass due to submergence, people shifted to further uphill areas and started to clear the forest for habitations and subsistence agriculture. People of more than 90% in Chittagong Hill Tracts (CHTs) live in remote areas, of which 70% directly

depend on forest and natural resources for their livelihood. Settlement of people from plain land to CHTs during 1978–1984 also changed the earlier dynamics of society nature and created pressure on forests and land resources. Forests and lands have become a serious livelihood issue and created chronic poverty and community conflicts on land. Newly constructed road to inaccessible area also increased the deforestation rate rapidly through settlement and abusive agriculture. In CHTs, population of indigenous communities on 13180-km^2 land was 61 957 and non-indigenous 1 097 in 1872 (Suhrawardy 1995), and total population in 2009 reached to 1.5 million (Wikipedia 2007). The number of shifting cultivators over the time also increased in CHTs. Here, about 2 163 families in 1964 were involved in shifting cultivation and 35 000 families in 2002 (Tripura and Harun 2003). Thus, areas of various categories of forests, viz. natural, bamboo, scattered trees and plantation in various forest units of CHTs reduced greatly over time. For example, natural forest in Kassalong was 76 195 ha in 1963 and 4 160 ha in 2005, and natural forest in Rankhiang 27 258 ha in 1963 and only 350 ha in 2005 (FRA 2005). This report also mentioned that more than 700 000-ha USF land was lacking forest covers on most of this land. During this period, vegetation cover of definite type is not permanent over an extensive area as well as in compact form, because of rotational shifting cultivation.

At present, Kaptai reservoir supports small-scale fisheries, which is rich in fish species diversity and contributing approximately 63 000-ton freshwater fish annually (Ahmed et al. 2001). As fishery is the secondary enterprise in this lake, the Bangladesh Fisheries Development Corporation has no control over the water level fluctuations (Ahmed and Hambrey 2005). Over the years, eight species of fish disappeared, seven species dwindled (Haldar et al. 2000).

Quality of surface water is important for long term uses, which affects community health, hampers aquaculture practices and also creates aesthetic problem in the locality. Every water-use requires a certain minimum water quality which ensures no harm to the user (Misra and Ahmed 1987; De 2000). At present land use changes, urban human habitation, inland navigation, tourism activity, as well as major development scheme in terms of road, bridge and other construction work are greatly affecting this fresh water resource. Available published literature show that previous studies on Kaptai Lake were on physical and chemical limnology by Khan and Chowdhury (1994), macro-benthic invertebrate fauna by Khan et al. (1996), population biology and environment of two carps by Azadi (1997), and environmental impact assessment by Alam et al. (2006). Under the changed conditions and pressures over time in CHTs as described above, this study was undertaken to evaluate water quality of the reservoir.

Materials and methods

Sampling stations

Water samples were collected from the five cross-sections of Karnaphuli River in dry and rainy season. The cross-sections from upstream to downstream of the river were Burburichara, Maichchari, Subolong, Basanthakum and Rangamati (Fig. 1). Burburichara was the upper sampling station in a straight channel from east to west locating about 35-km upstream from the dam site of Kaptai. At this cross-section both the banks were steep with low sediment deposition. The second sampling site, Maichchari, was about 6-km downstream from Burburichara cross section, located beside the main Karnaphulli channel. River flow of shallow depth at this site in bended channel with gentle sloping bank was very slow to nil.

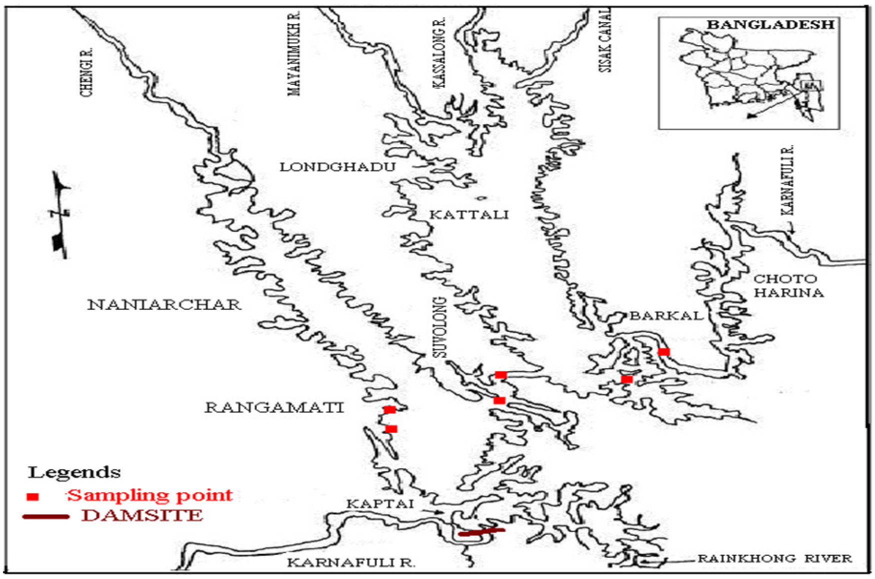

Fig. 1 Sampling station along the Karnaphuli River, in Chittagong Hill Tracts, Bangladesh

Subolong sampling site was about 13-km downstream of Burburichara station forming steep gorge of about 85-m wide and 30-m deep after the confluence of Kasalong tributary. This point experienced a high discharge from Kasalong making turbulence at the confluence on the main river course. The fourth sampling site was at Basanthakum, lying between Rangamati and Subolong, 20-km downstream from Burburichara station. At this site, one side of the river had steep gorge and the other side was shallow in depth with enhanced silt deposition.

The last water samplings were near Rangamati town at two points. One point was at busy inland public harbor. The other sampling point was at private harbor, where 2-3 boats travel daily and situated beside residential area of the town.

Collecting and processing water samples

At all the sampling sites, water was collected in high-density PVC bottles from the middle part of the reservoir at fractional depths of 0.2 and 0.8 (Hewlett 1982), except for Rangamati points. At Rangamati point only surface water was collected. Before collection of water sample, the bottles were thoroughly cleaned by rinsing with 8N HNO_3 and de-ionized water, followed by repeated washing with water at collection site (De 2000). Velocity of water flow was measured using Geopack digital velocity meter at each sampling point. Sample bottles were immediately transported to the laboratory keeping in an icebox at a temperature of <4°C for subsequent analysis.

Water analysis

Suspended solid in water was determined by filtering collected sample through Whatman filter paper No. 42 and drying the content of filter paper at 103°C in an oven for 3 h. Total dissolve solid (TDS) was calibrated in standard TDS solution of ambient temperature on the day of analysis. Total solid was the sum of TDS and suspended solid. Water pH was measured by TOA pH meter keeping sample temperature from 25°C to 27°C. Before analysis, pH meter was adjusted by standard buffer solution of pH 4.00 and 7.00. Conductivity of water sample was also measured by conductivity meter keeping sample temperature from 25°C to 27°C. Chloride was determined by 0.05N silver nitrate solution using potassium chromate indicator. Chemical oxygen demand (COD) was determined by titrating re-flasked sample in ferrous ammonium sulfate using ferrion indicator (Huq and Alam 2005). Bicarbonate (HCO_3^-) was determined by titrating sample against 0.02N H_2SO_4 solution and adding phenolphthalein indicator. Nitrate was determined colorimetrically by salicylic acid method, sulfate by $BaCl_2$ method, phosphate by ammonium sulphomolybdate and stannous chloride solution method using Jennway spectrophotometer (Huq and Alam 2005). Total Na^+ and K^+ were determined by Flame photometry, and Ca^{2+} and Mg^{2+} by Atomic Absorption Spectrophotometry (AAS) using 3.5% $LaCl_3$ solution (Petersen 2002).

For determination of Ca^{2+}, $LaCl_3$ solution was prepared by taking 87-g $LaCl_3.7H_2O$, 20-mL HNO_3 of 5M and 80-mL water in a beaker and contents were heated gently to dissolve the salt and allowed to cool. Again, 60-mL HNO_3 of 5M was added and transferred in a 1000-mL volumetric flask, to the volume with distilled water and mixed thoroughly. Concentration of Ca^{2+} in water was then determined using AAS against standard Ca^{2+} solution. For determination of K^+, stock solution was prepared by dissolving 0.9527-g oven dried KCl crystal in distilled water in a 1000-mL volumetric flask. This stock solution was diluted to 5 different concentrations to give standards (Huq and Alam 2005).

Results and discussion

Water pH of Kaptai reservoir in rainy season was less than that in dry season in both 0.2-and 0.8-fractional depth at all the locations (Table 1 and 2). Lower pH in the river water was due to a fresh free CO_2 supply after long spell of heavy monsoon rain (Khan et al. 1996). In rainy season, pH in 0.2-fractional depth was more than that in 0.8-fractional depth at almost all the locations and reverse trend showed in dry season. This result was also in agreement with that from Khan et al. (1996) who observed increase in pH with depth in this lake. However, water pH at Rangamati points was similar in both the seasons due to absence of inflow and outflow of water being situated away from the flowing channel (Table 3). At all locations of the reservoir, pH values were less than standard limits of 6.5–8.5 for fish culture, indicating unsuitability of water for the purpose (Boyd 1998). Most fish species live well within the pH range from 6.5 to 9.5 and fish fries were often sensitive to pH level above 9.0 to 9.5. Chronic pH levels below 6.5 may reduce fish reproduction and sometimes kill fishes in the late winter**.** However, the increased concentration of alkali helps to buffer against pH changes (Boyd 1998; Tucker 1991).

Conductivity of reservoir was 2-4 fold higher than that in rainy season, containing higher concentration of Na^+ (Table 1 and 2). Water conductivity varied from 72 to 80 $\mu S \cdot cm^{-1}$ in rainy season and from 156 to 281 $\mu S \cdot cm^{-1}$ in dry season, and decreased gradually from upstream to downstream. Conductivity range in rainy season was less than that in dry season and higher than biennial mean value of 106.3 $\mu S \cdot cm^{-1}$ (Azadi 1997). Lower conductivity in rainy season was related with saline run off water and higher conductivity in dry season with reduced water inflow in the reservoir. The reason mentioned for pH change was also true for increased conductivity in the upstream, compared to downstream. The conductivity near Rangamati town was less than that of any other points at upstream of the reservoir in both the seasons (Table 3) due to same reason as mentioned for pH. Conductivity was almost similar in rainy season at both 0.2-and 0.8-fractional depth and lower in surface water in dry season. Acceptable conductivity values for fisheries range from 30 to 5 000 $\mu S \cdot cm^{-1}$ (Boyd 1998) and all the conductivity values of the reservoir were within this range. Freshwater fish generally thrive over a wide range of electrical conductivity. Minimum salt content is also desirable for fish to maintain osmotic balance and some fish species such as Channel catfish can withstand upper salinity limit up of 30 000 $mS \cdot cm^{-1}$.

Both total solids and total dissolved solids were higher in upstream and decreased gradually towards downstream in the reservoir (Table 1 and 2) due to decrease in velocity of flowing water in both the seasons. The suspended solid in the reservoir varied from 470.71 mg·L^{-1} at Basanthakum to 1967.34 mg·L^{-1} at Burburichara in rainy season and from 90.71 at Basanthakum to 271.53 mg·L^{-1} at Maichchari in dry season. The suspended solid in Rangamati station varied from 310.67 to 314.24 mg·L^{-1} in rainy season and 80.67 to 84.24 mg·L^{-1} in dry season. Its amount at all sampling stations was beyond permissible limits of 80 mg·L^{-1} for fish culture, because higher amount of suspended solid in the reservoir contributed to a high turbidity restricting light penetration. However, dissolve oxygen level was not affected by the organic matter loading from runoff water due to turbulence flow and short residence time of suspended solid in the water before settling as a bed load. Total dissolved solids at upstream were 60 mg·L^{-1} and at down stream 30 mg·L^{-1}, which in rainy season was higher than that in dry season.

Table 1. Water quality of Kaptai reservoir in Chittagong Hill Tracts at four sampling stations determined in rainy season on 11 September, 2007

Station	Fractional depth	pH	Conductivity (μS·cm^{-1})	HCO_3 (mg·L^{-1})	TDS (mg·L^{-1})	TS (mg·L^{-1})	Ca^{2+} (mg·L^{-1})	Mg^{2+} (mg·L^{-1})	Na^+ (mg·L^{-1})	K^+ (mg·L^{-1})	NO_3-N (μg·L^{-1})	SO_4^{2-} (mg·L^{-1})	PO_4^{3-} (mg·L^{-1})	DO (mg·L^{-1})	COD (mg·L^{-1})
Burburichara	0.2	5.59	72.50	61.00	40.00	1226.67	10.11	1.51	7.60	22.75	2.15	1.56	0.03	7.26	75.00
	0.8	5.85	72.00	61.00	60.00	1967.34	9.21	1.49	7.00	22.00	1.35	4.17	0.04	6.50	55.00
Maichchari	0.2	6.20	80.00	91.50	50.00	726.67	6.01	1.98	8.60	20.50	1.01	2.66	0.02	7.10	72.50
	0.8	5.90	78.00	31.00	40.00	1271.53	5.02	1.28	6.40	17.50	1.18	1.11	0.01	6.52	75.00
Subolong	0.2	6.03	77.50	31.00	40.00	811.43	7.02	1.08	9.60	27.00	3.90	2.18	0.01	7.14	55.00
	0.8	5.60	78.00	46.00	40.00	646.06	7.03	1.28	8.60	27.00	2.28	3.12	0.01	6.75	57.50
Basanthakum	0.2	5.48	77.50	61.00	30.00	470.71	6.19	1.16	6.80	19.75	2.14	1.46	0.03	7.20	22.50
	0.8	5.36	78.50	61.00	30.00	927.32	4.88	1.25	9.40	26.50	1.75	2.16	0.02	6.82	15.00

Table 2. Water quality of Kaptai reservoir in Chittagong Hill Tracts at four sampling stations determined in dry season on 10 April, 2008

Station	Fractional depth	pH	Conductivity (μS·cm^{-1})	HCO_3 (mg·L^{-1})	TDS (mg·L^{-1})	TS (mg·L^{-1})	Ca^{2+} (mg·L^{-1})	Mg^{2+} (mg·L^{-1})	Na^+ (mg·L^{-1})	K^+ (mg·L^{-1})	NO_3^- (μg·L^{-1})	SO_4^{2-} (mg·L^{-1})	PO_4^{3-} (mg·L^{-1})	DO (mg·L^{-1})	COD (mg·L^{-1})
Burburichara	0.2	6.40	272.00	61.00	70.00	226.67	9.01	1.31	13.00	8.00	1.39	2.91	0.06	6.66	10.00
	0.8	6.40	278.00	61.00	90.00	167.34	8.71	1.29	12.50	7.20	0.75	2.80	0.07	6.10	8.00
Maichchari	0.2	6.00	278.00	130.00	120.00	126.67	5.40	1.96	18.00	6.50	5.01	2.61	0.11	6.15	8.00
	0.8	6.30	281.00	122.00	110.00	271.53	4.05	1.20	14.20	6.00	4.58	2.23	0.19	5.90	8.00
Subolong	0.2	5.70	159.00	30.50	50.00	121.43	6.22	0.98	18.60	30.00	0.96	6.12	0.22	6.64	15.00
	0.8	6.20	170.00	61.00	40.00	104.06	6.23	1.18	20.50	32.00	1.18	5.29	0.21	6.02	12.00
Basanthakum	0.2	6.00	156.00	122.00	60.00	90.71	5.15	1.06	16.50	9.40	3.31	2.61	0.08	6.58	12.00
	0.8	5.90	164.00	122.00	40.00	97.32	3.48	1.15	14.25	8.30	3.73	3.83	0.23	6.10	12.00

Table 3. Surface water quality of Kaptai reservoir near Rangamati city in Chittagong Hill Tracts in rainy and dry seasons

Season	Sampling point	pH	Conductivity (μS·cm^{-1})	HCO_3 (mg·L^{-1})	TDS (mg·L^{-1})	TS (mg·L^{-1})	Na^+ (mg·L^{-1})	K^+ (mg·L^{-1})
Rainy	Reservebazar	5.47	97.33	71.33	53.33	314.24	10.80	3.42
	Sufia Ghat	5.53	99.00	51.00	66.67	310.67	13.33	3.22
Dry	Reservebazar	6.07	138.00	50.83	46.67	84.24	6.53	1.13
	Sufia Ghat	6.93	135.67	50.83	26.67	80.67	5.59	1.14

Season	Sampling point	Ca^{2+} (mg·L^{-1})	Mg^{2+} (mg·L^{-1})	NO_3^- (mg·L^{-1})	SO_4^{2-} (mg·L^{-1})	PO_4^{3-} (mg·L^{-1})	DO (mg·L^{-1})	COD (mg·L^{-1})
Rainy	Reservebazar	9.01	1.31	1.79	0.76	0.03	6.15	21.67
	Sufia Ghat	8.71	1.29	1.96	1.64	0.01	6.90	15.00
Dry	Reservebazar	13.42	2.80	0.89	3.50	0.32	5.65	48.00
	Sufia Ghat	13.13	3.33	2.46	2.91	0.12	6.25	18.25

Bicarbonate or alkalinity of the reservoir in rainy season was less than that in dry season. Its values varied from 31.0 to 91.50 mg·L^{-1} in rainy season and from 30.50 to 130.00 mg·L^{-1} in dry season (Table 1, 2). At Maichchari, concentration of HCO_3^- was exceptionally high both in dry and rainy seasons. Rangamati samplings showed similar alkalinity at both the points - Reservebazar and Sufia's Ghat, where concentration of HCO_3^- varied from 51.00 to 71.33 mg·L^{-1} in rainy season (Table 3). The permissible limit value of HCO_3^- concentration was from 50 to 300 mg·L^{-1} for aquaculture (Boyd 1998) and most values in Kaptai reservoir were within this limit, indicating water suitability for aquaculture with respect to this property.

Concentration of sodium content was slightly higher in surface water, compared to 0.8-fractional depth in both the seasons and decreased gradually from upstream to downstream. Sodium concentration in dry season was almost more than doubled that in

rainy season. Concentration of K^+ in water did not show any definite trend with depth of water as well as for seasonal variations and from upstream to downstream. However, general trend for K^+ in rainy season was higher than that in dry season (Table 1 and 2). Concentration of Na^+ and K^+ at Rangamati sampling points was higher, compared to other cross-sections in reservoir, except K^+ in rainy season. However, concentrations of Na^+ and K^+ in dry season were higher than those in rainy season (Table 3). Similar to other parameters, Maichchari cross-section contained more Na^+ and K^+, compared to other locations. All K^+ values in rainy season at different cross-sections and at Subolong in dry season were higher than permissible limits of 1–10 mg·L^{-1} and all Na^+ values in both the seasons felled within the permissible limit of 2–100 mg·L^{-1} for aquaculture (Boyd 1998).

Concentration of NO_3-N in water showed no definite trend with depths, locations and seasons (Table 1 and 2) and samplings at Rangamati showed similar NO_3-N concentration both in rainy and dry seasons (Table 3). These findings were in agreement with Khan et al. (1996), who also did not found any definite pattern for this compound in this lake. Concentration of NO_3-N in water at different locations ranged from 0 to 61.11 µg·L^{-1} and felled within the recommended limit values of 0.2–10 mg·L^{-1} for aquaculture (Boyd 1998). Nitrate is relatively nontoxic to fish health, except at exceedingly high levels above 90 mg·L^{-1} (Tucker 1991).

Concentrations of SO_4^{2-} and H_2PO_4-P of reservoir at surface were less than those at greater depth, with few exceptions, in both the seasons, which did not show any definite trend from upstream to downstream. However, H_2PO_4-P content in the reservoir in dry season was much higher than that in rainy season in all the locations. Khan et al. (1996) also found a prominent increase of H_2PO_4-P in dry season, compared to rainy season in this lake. Concentration of P in all the locations was within the recommended limits of 0.01–3.00 mg·L^{-1} for fish culture (Boyd 1998). Phosphorus in the reservoir ranged from 10 to 80 µg·L^{-1}, which exceeded normal average of unpolluted water with dissolved P level of the world around 25 µg·L^{-1} (Wetzel 2001). Concentration of SO_4^{2-} at Rangamati points varied from 0.76 to 1.64 mg·L^{-1} in rainy season and 2.91 to 3.50 mg·L^{-1} in dry season. The safe limits for SO_4^{2-}-S concentration for aquaculture ranged from 5 to 100 mg·L^{-1} (Boyd 1998) and values in both the seasons were much below this range, except at Subolong, in dry season. Sulfate is a common compound in water as a result of dissolution of minerals and rocks. This compound typically ranges between 0 and 1 000 mg·L^{-1}. Fish tolerates a wide range of sulfate concentrations and sulfate level above 500 mg·L^{-1} only (Tucker. 1991).

Concentrations of $Ca^{2+}$and Mg^{2+}in the reservoir in upstream were higher than those downstream, which at Rangamati sampling points were higher than those in any other locations. Concentration of Ca^{2+} at 0.2-fractional depth was higher and Mg^{2+} less than those at 0.8-fractional depth at almost all the four locations. Concentrations of Ca^{2+} and Mg^{2+} at all the locations were within the recommended values of 5–100 mg·L^{-1} for fisheries (Boyd 1998).

Dissolve oxygen (DO) of the reservoir in surface water consistently was higher than that in 0.8-fractional depth in both the seasons, which in rainy season was slightly higher than that in dry season at almost all the locations. Values of DO in water in rainy season varied from 6.15 to 7.26 mg·L^{-1} and in dry season from 5.65 to 6.66 mg·L^{-1}. Optimum DO values for fisheries ranged from 4 to 6 mg·L^{-1} (Boyd 1998), below which most aquatic organisms could not survive. In other word, dissolve oxygen concentration was in safe level in all the locations of Kaptai reservoir.

Concentration of P was more in the lake water. However, higher dissolved oxygen level through out the year revealed that lake water was not affected substantially with the presence of uncontrolled pollutants from various sources. Commonly occurring pollution sources in the lake were oil and fecal from water transportations and from all sorts of thrown materials including solid wastes by many unconscious visitors. Alam et al. (2006) reported that dissolve oxygen in Kaptai reservoir ranged from 5 to 6 mg·L^{-1} for average value of the whole depth, which remained mostly uniform in different water depths in the rainy season. As the water surface warms up in the dry season, oxygen depletion occurs in the deeper layer up to a depth of 8 to 15 m, which again shows cooling effect from mid May through rainfall. Low dissolved oxygen can be lethal to aquaculture species through stress development, which increased susceptibility to disease and reduced food conversion efficiency.

Chemical oxygen demand (COD) of the reservoir doubled in rainy season, compared to dry season, and gradually decreased from upstream toward downstream (Table 1 and 2). COD values in rainy season varied from 15 to 75 mg·L^{-1} and in dry season from 8 to 48 mg·L^{-1}. COD values in rainy season were almost similar at different water depths, which in dry season increased at 0.2-fractional depth, compared with 0.8-fractional depth. Water was oxygenated at the end of May for the whole depth, except the lower layer. The lower layer remained deoxygenated mostly. Table 3 provides a glimpse of water pollution in Karnafully River at Reservebazar point, where reservoir had higher COD and lower DO level. Urban points at Rangamati contained higher COD than other locations of the reservoir. Again, COD values in rainy season were higher than those in dry season. Larger difference in COD between rainy and dry seasons was associated with greater reduction in organic matter in dry season. This is more favored for aquaculture due to good water quality. In the reservoir, iron content was trace in amount (<0.001 mg·L^{-1}) and chloride almost absent, indicating no danger for fish culture with respect to these two elements.

Among determined water qualities, the most alarming property was the presence of excessive amount of suspended solids in the reservoir. This was related with eroded material coming from surrounding barren hills. Lacking of forest cover on most of the hills in CHTs was again related with many human activities such as, over and illicit felling of trees, shifting cultivation, frequent burning, and improper construction of road and infrastructure. The other feature of water pollution was from throwing of solid wastes by the inhabitants and visitors in the lake and fecal pollution from fishers and other boatmen occurring in every time in any part of the lake.

From construction of dam for generation of electricity at Kaptai on Karnafuly river, ecological changes have taken place both above and below parts of this structure. Before construction of dam, this lake was the continuation of Karnaphuli river, originated from Lusai hills of India. Then, this river flew with full velocity and carried almost all sediments to the Bay of Bengal. After construction of Kaptai dam, many agricultural fields and settlements went under water and people moved to further upward, cleared more forests for habitation and cultivation for requirements of their daily needs. The result is that, over the years soil erosion increased greatly on the upland watershed in absence of forest cover. On the other hand, with the construction of dam more total solids are now settling every year due to creation of stagnant condition in previously flowing water. In effect, many changes on land features and in ecological condition have been taken place through deposition of sediments. Reservoir bed has come up and islands have been developed in many places between 1955 and 2010. In the rainy season above the dam due to overflow of water in many agricultural fields, settlements, markets and other establishments go under water. So, when water is released from the over flown lake in rainy season, a greater area below the dam having very dense population becomes flooded. For this reason transportation system is completely disrupted for several days and also damages growing crops of people living at the down stream area. Again, in the dry season due to sediments from ceasing of seepage water, navigation problem arises for million of people living in Rangamati hill district as well as for people who traveled to this hilly region from the other parts of the country for business, tourism and other purposes. Moreover, in this season electricity production at Kaptai is also hampered due to greater fall down of water level.

Conclusion

Water quality parameters of Kaptai reservoir such as, Na^+, Ca^{2+}, Mg^{2+}, TDS, SO_4^{2-}, Cl^-, DO and COD concentrations were in favor of aquaculture. Owing to high concentration of nitrate and phosphorus, reservoir water represents mesotrophic condition. Bicarbonate and pH are not in favorable condition for its great potential inland fisheries. Presence of excessive amount of suspended solids in the reservoir is at most alarming condition. Moreover, urban pollution has threatened the water for domestic use and for supply in Rangamati town. Under the situation, it is necessary to have control measures to stop pollution with the aim to sustain the life of this lake.

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